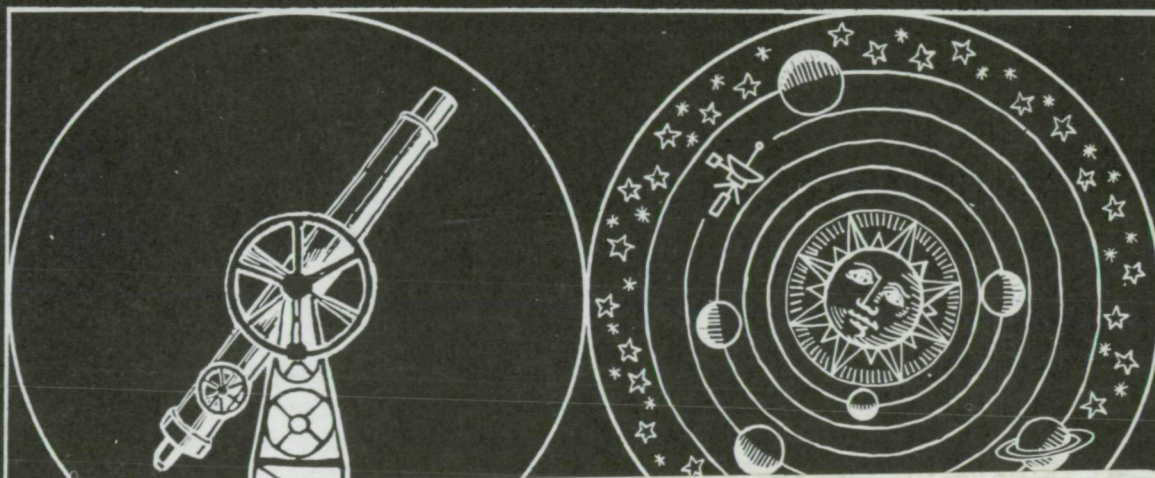


# SPACE SCIENCE

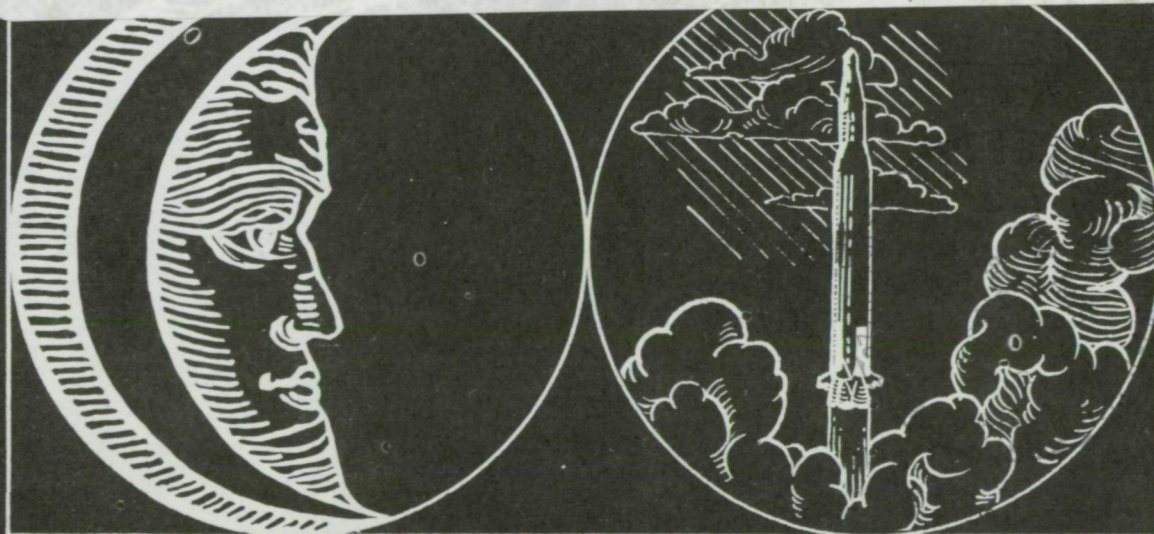


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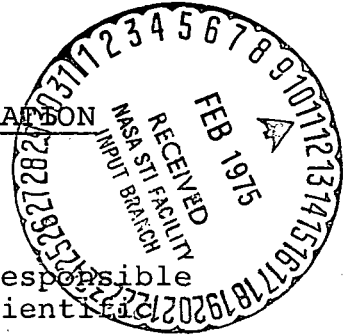
CONTENTS

(Editors: This fact sheet contains information on NASA's space science program. It is suggested that it be retained in your files.)

BACKGROUND ON THE SPACE SCIENCE PROGRAM .....	1-2
PHYSICS AND ASTRONOMY PROGRAMS .....	3-24
Aeros (German A-2) .....	3
Netherlands Astronomical Satellite (ANS) .....	4
Atmosphere Explorer .....	5
Dual Air Density Explorer (DAD) .....	6
Fawkeye/Neutral Point Explorer .....	7
High Energy Astronomical Observatory (HEAO) .....	8
INTASAT .....	9
International Sun-Earth Explorers (ISEE) .....	10
International Satellite for Ionospheric Studies (ISIS) .....	11-12
International Ultraviolet Explorer (IUE) .....	13
Interplanetary Monitoring Platform (IMP) .....	14
Large Space Telescope .....	15
Orbiting Astronomical Observatory (OAO) .....	16-17
Orbiting Solar Observatory (OSO) .....	18
Radio Astronomy Explorer (RAE) .....	19
Small Astronomy Satellite (SAS) .....	20
Small Scientific Satellite (SSS-A) .....	21
UK-5 .....	22
Sounding Rockets .....	23-24
PLANETARY PROGRAMS .....	25-38
Mariner Mars 1971 .....	25-26
Mariner Venus/Mercury 1973 .....	27-28
Mariner Jupiter/Saturn 1977 .....	29-30
Pioneer 10 and Pioneer 11 .....	31-33
Viking .....	34-35
Helios .....	36-37
Pioneer Venus 1978 .....	38
LUNAR PROGRAMS .....	39
OSS LAUNCH VEHICLES .....	40-44
Scout .....	40
Delta .....	41
Atlas/Centaur .....	42
Titan III C .....	43
Titan III E/Centaur .....	44

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

OFFICE OF SPACE SCIENCE



NASA's Office of Space Science (OSS) is responsible for automated space missions to make direct scientific measurements in space.

A new technology--that of space--has in the 15 years of NASA's history provided a detailed knowledge of the environment of Earth in space, a first understanding of our neighboring planets, and expanded knowledge of the solar system and the universe.

In that period, OSS and its predecessor, the Office of Space Science and Applications, have launched more than 300 spacecraft into Earth orbit or interplanetary space and have launched more than 1,700 sounding rockets into near-Earth space.

Earth-orbiting satellites have discovered and mapped in detail the highly complex magnetosphere surrounding Earth and the effect of solar radiation on Earth's ionosphere and atmosphere. Other spacecraft, orbiting above the obscuring curtain of Earth's atmosphere, have looked far into space to study ultraviolet, infrared, X-ray and gamma ray radiations to learn more about the stars, galaxies, pulsars and quasars.

Automated spacecraft have orbited Mars and have flown by Venus, Mercury and Jupiter, contributing to an understanding of those planets and why they are different from the planet Earth. Other far-ranging spacecraft have mapped the Moon in detail and observed the Sun and the solar wind from widely separated points in the solar system.

To launch automated spacecraft, OSS has developed a highly-reliable stable of versatile launch vehicles: Scout, Thor-Delta and Atlas-Centaur. Adaptation of the Titan III and Titan III-Centaur for launch of larger automated spacecraft is underway.

In addition, for study of near-Earth space phenomena, balloons and sounding rockets are launched from a variety of ranges throughout the world. High-flying aircraft also are employed to carry astronomical instruments above most of Earth's atmosphere for stellar studies. OSS also supports a program of astronomical observations with Earth-based telescopes.

Satellites provided by a number of other governmental agencies, corporations and universities also are launched by OSS. These include operational spacecraft such as the Intelsat communications satellites and the Improved Tiros weather satellites. A variety of advanced technology satellites have been launched for NASA's Office of Aeronautics and Space Technology.

Acting under agreements executed by NASA's International Programs Office, similar launches are conducted by OSS for institutions abroad. British, Canadian, Italian, German, Netherlands, and French satellites, as well as scientific satellites of the European Space Research Organization (ESRO), have been launched.

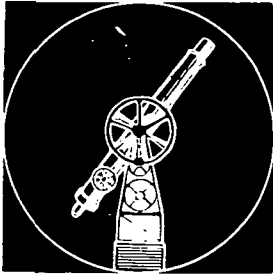
In the case of OSS launches for both foreign and domestic institutions, NASA may cooperate in the development of the satellite, the launch, and the reduction of the data. In other cases, the institution develops its own satellite and purchases the launch vehicle and support services from NASA.

Although it accounts for only about 7 per cent of the OSS budget, Supporting Research and Technology (SR&T) is the underlying foundation for OSS's space exploration. Within this program, studies are conducted upon which decisions concerning the space flight program are based.

The main objectives of the SR&T program are to:

- develop concepts and strategy for future flight missions,
- develop the technology to carry out future missions,
- acquire fundamental knowledge in the scientific disciplines to which the flight program is dedicated,
- and apply that fundamental knowledge by providing technical consultation to other governmental agencies.

For management purposes, Office of Space Science programs are divided into Physics and Astronomy Programs, Planetary Exploration Programs, Lunar Exploration Programs, and Launch Vehicle and Propulsion Programs.



# Physics and Astronomy

**Program:** AEROS (German A-2)

**Description:** AEROS is a 125-kilogram (275-pound) spacecraft designed to measure the main aeronomic parameters determining the state of the upper atmosphere and the solar ultraviolet radiation in the wavelength band of main absorption. The spin-stabilized satellite is designed to orbit Earth at a distance of 218 kilometers to 864 kilometers (135 to 537 miles).

**Schedule:** AEROS-A was launched December 16, 1972, from Western Test Range. Launch vehicle, Scout. Ceased operation on Aug. 22, 1973. AEROS-B was launched on July 16, 1974.

**Management:** Project management, Goddard Space Flight Center and Gesellschaft fuer Weltraumforschung (GFW). Industrial contractor, Dornier Systems.

**Program Officials:** Program managers, M. Ottenbein and John R. Holtz;  
Project managers, H. Schreiber and C. L. Wagner, Jr. (GSFC);  
Program scientists, Erwin R. Schmerling and E. Lubbert;  
Project scientists, P. Lammerzahn and S. J. Bauer (GSFC).

**Funding:** \$1.8 million obligated through June 1975.



Program: Netherlands Astronomical Satellite  
(ANS) (NASA/Netherlands cooperative  
project)

Description: This 132-kilogram (291-pound)  
satellite will carry instruments  
designed to obtain spectral distri-  
bution and other data from celestial  
X-ray and ultraviolet sources. Sta-  
bilized by three axis wheels and  
magnetic coils, ANS will be placed  
in a 560 x 510 kilometer (348 to 316  
miles) sun synchronous polar orbit. Its  
designed lifetime is six months.

Schedule: Launch, August 27, 1974, from Western  
Test Range. Launch vehicle, Scout.

Management: Project management for NASA, Goddard  
Space Flight Center.  
Project management for the Netherlands,  
Netherlands Institute for Aeronautics  
and Space. (NIVR)  
Spacecraft management, Fokker/Phillips.

Program Officials: Program manager, John R. Holtz;  
Project manager, E. W. Hymowitz (GSFC);  
Program scientist, Nancy G. Roman;  
Project scientist, T. P. Stecher.

Funding: \$3.2 million obligated through June 1974.

Program: Atmosphere Explorer

Description: These are 660-kilogram (1,450-pound) Explorer-class spacecraft to be launched by Delta rocket into elliptical Earth orbits of different inclinations to make scientific studies of the photochemical processes and energy transfer mechanisms which control the structure and behavior of the Earth's atmosphere and ionosphere through the region of high solar energy absorption. An on-board propulsion system will permit the spacecraft to make changes in their orbit while investigating in detail the regions between 120 and 155 kilometers (1/4 to 96 miles) above the Earth.

Schedule: Atmosphere Explorers D and E to be launched from Western or Eastern Test Range in 1975. AE-D will be placed in a near polar orbit; AE-E, in a near equatorial. Three previous launches: Explorer 17 in April 1953, Explorer 32 in May 1966, and Explorer 51 in 1973.

Management: Project management, Goddard Space Flight Center. Industrial contractor for Atmosphere Explorers C, D, and E, RCA Corp.

Program Officials: Program manager, Frank W. Gaetano;  
Project manager, David W. Grimes (GSFC);  
Program scientist, Erwin R. Schmerling;  
Project scientist, Nelson W. Spencer (GSFC).

Funding: \$47.8 million obligated through June 1974.

Program: Dual Air Density Explorer, (DAD)

Description: Two 40-kilogram (88-pound) spacecraft will be launched by one vehicle 400 to 1,500 kilometers (248 to 932 miles) and 700 to 1,500 kilometers (434 to 932 miles) co-planar Earth orbits to obtain global density measurements of the upper thermosphere and the lower exosphere, to measure the vertical structure of the atmosphere as a function of latitude, season, and local solar time, and to perform composition measurements--with a unique mass spectrometer system--of the upper atmosphere and the lower exosphere.

Schedule: DAD will be launched in late 1975 from the Western Test Range. Launch vehicle, Scout.

Management: Project management, Langley Research Center. Contractor, (for mass spectrometer), University of Minnesota.

Program Officials: Program manager, J. R. Holtz;  
Project manager, J. E. Canaday, Jr.  
(LaRC);  
Program scientist, Erwin R. Schmerling  
Project scientist, E. J. Prior (LaRC).

Funding: \$15.6 million obligated for DAD/Hawkeye through June 1974.



**Program:** Hawkeye/Neutral Point Explorer

**Description:** Hawkeye was designed to investigate the polar magnetosphere at high altitudes, and the boundary of the magnetosphere in the vicinity of neutral points by measuring charged particles and magnetic fields. The 27-kilogram (58-pound) spin-stabilized spacecraft was launched into an Earth orbit with an apogee of approximately 125,570 kilometers (75,342 miles) and a perigee of 470 kilometers (282 miles).

**Schedule:** Launched in June 1974 from the Western Test Range by a five-stage Scout rocket.

**Management:** Project management, Langley Research Center. Contractors, University of Iowa, Ball Brothers Research Corp.

**Program Officials:** Program manager, J. R. Holtz;  
Project manager, C. W. Coffee, Jr.  
(LaRC);  
Program scientist, L. D. Kavanagh, Jr.;  
Project scientist, J. A. Van Allen  
(University of Iowa).

**Funding:** See funding for Dual Air Density Explorer (DAD); previous page.

**Program:** High Energy Astronomy Observatory  
(HEAO)

**Description:** The HEAO program consists of three spacecraft, HEAO-A B, and C; each will carry 1,300 kg (2,950 lb.) payloads of scientific instruments to study some of the most intriguing mysteries of the universe--very energetic radiation from space, X-rays, gamma rays and cosmic rays. These have been seen previously by sounding rockets and balloons and by small satellites with lower resolution and sensitivity. There is strong evidence that supernovae and pulsars are X-ray sources and some weaker evidence that links X-rays with radio galaxies and quasars. HEAO, a 2700-kilogram (6000 pound), 5.6-meter (22-feet) long spacecraft, will be launched by an Atlas Centaur rocket into a 425-kilometer (264-mile) orbit.

**Schedule:** Launches in 1977, 1978 and 1979, from Eastern Test Range.

**Management:** Marshall Space Flight Center.  
Industrial contractor for spacecraft systems: TRW, Inc., Redondo Beach, Calif.

**Program Officials:** Program manager, R. E. Halpern;  
Project manager, F. A. Speer (MSFC);  
Program scientist, A. G. Opp;  
Project scientist, F. B. McDonald (GSFC).

**Funding:** \$37.2 million obligated through June 1974.

**Program:** INTASAT (Instituto Nacional de Technica Aeroespacial Satellite)  
(NASA/Spain cooperative project)

**Description:** Objective of the INTASAT mission is to conduct worldwide observations of ionospheric total electron count, ionospheric irregularities, and ionospheric scintillations. The 15-kilogram (37-pound) spacecraft is magnet-stabilized. It will orbit the Earth at approximately 1,450-kilometers (901 miles).

**Schedule:** Launched as a piggyback spacecraft with ITOS-G in October 1974 by a Delta vehicle from the Western Test Range.

**Management:** Project management for Spain: Instituto Nacional de Technica Aeroespacial (INTA)  
Project management for NASA: Goddard Space Flight Center.

**Program Officials:** Program managers, John R. Holtz (NASA) and INTA.  
Project managers, J.M. Dorado, INTA and William R. Wilt, GSFC.  
Program scientist, L. Sanchez, INTA and Erwin R. Schmerling, GSFC.

**Funding:** \$6,000 obligated through June 1974.

Program: International Sun-Earth Explorers (ISEE)  
(Joint effort between NASA and ESRO)

Description: This program consists of two Delta launches of three spacecraft; one vehicle will carry two spacecraft identified as ISEE-A and B, and the second vehicle will carry a spacecraft identified as ISEE-C. This mission will investigate solar-terrestrial relationships at the outermost boundaries of the Earth magnetosphere, to examine in detail the structure of the solar wind near Earth, and the shock wave which forms the interface between the solar wind and Earth, and to continue the investigation of cosmic rays and solar flares in the interplanetary region near 1 AU. ISEE-A and B with station-keeping ability, will be in a highly elliptical Earth orbit with an apogee of 18-23 Earth radii; ISEE-C will be at 1 AU in the interplanetary medium. Design weights are 306 kilogram (674 pounds) for A, 135 kilograms (300 pounds) for B, and 430 kilograms (948 pounds) for C.

Schedule: Launch of A and B in late 1977 and Heliocentric in late 1978.

Management: NASA project management: Goddard Space Flight Center (GSFC);  
ESRO project management: European Space Technology Center (ESTEC).

Program Officials: Program managers, J. R. Holtz (NASA) and J. Ortner (ESRO);  
Program scientists, Erwin R. Schmerling (NASA) and G. Haskell (ESRO);  
Project managers, J. Madden (GSFC) and D. Eaton (ESTEC);  
Project scientists, (A/B) - K. Ogilvie (GSFC) and D. Page (ESTEC);  
(H) - T. von Rosenvinge (GSFC).

Funding: Initial project funding in FY 1975.

**Program:** International Satellite for  
Ionospheric Studies (ISIS) (A  
cooperative project with Canada)

**Description:** The ISIS satellites, designed and  
built by Canada, are launched from  
the Western Test Range into polar  
orbits to develop a better under-  
standing of ionosphere physics.  
They measure, by latitude, daily and  
seasonal fluctuations in the  
electron density of the upper iono-  
sphere, study radio and cosmic noise  
emissions and conduct correlative  
direct measurements of the  
energetic particles interacting  
with the ionosphere. The roughly  
225 to 270-kilogram (500 to 600-  
pound) spacecraft were placed into  
orbit by a NASA-supplied Delta launch  
vehicle.

**Schedule:** ISIS 2 was launched March 1971 into  
a circular orbit of about 1,400  
kilometers (870 miles). This space-  
craft was the last in the pro-  
gram and no additional launches  
are planned. Previous launches  
included Alouettes 1 and 2 in  
September 1962 and November  
1965, respectively, and ISIS-1  
in January 1969.

**Management:** For Canada: The Communications  
Research Center, Department of  
Communications.

For NASA: Goddard Space Flight  
Center.

**Program Officials:** Program manager, Frank Gaetano;  
Project manager, John E. Jackson  
(GSFC);  
Program scientist, Dr. Erwin R.  
Schmerling;  
Project scientist, John E. Jackson  
(GSFC).

- 12 -

For Canada: Program manager,  
Dr. Colin A. Franklin;  
Deputy program manager, Harold R. Raine.

**Funding:**

\$13.3 million obligated by NASA for program through June 1974.

- more -

Program: International Ultraviolet Explorer (IUE)

Description: The IUE is a 644-kilogram (1,416-pound) Explorer-class spacecraft (including a 260-kilogram (570-pound) third stage apogee motor) which is designed to obtain high-resolution ultraviolet (UV) data on the spectra of many types and classes of astronomical objects. This 3-axis stabilized spacecraft will be launched into a geosynchronous orbit and will be in sight of a U.S. ground station at all times. Spacecraft capabilities, in conjunction with the orbit, will allow real-time operations similar to those accomplished at ground based optical telescope facilities. This will permit astronomers to perform ground-based observations while concurrently receiving satellite data.

Schedule: Launch by a Delta vehicle is planned from Eastern Test Range (ETR) in 1976.

Management: Project management: Goddard Space Flight Center, which will develop the spacecraft in-house. The United Kingdom (U.K.) will supply the image tubes for the spectrograph and acquisition field camera. ESRO will provide the solar paddles as well as installation of an European ground station.

Program Officials: Program manager, John R. Holtz;  
Program scientist, Nancy G. Roman;  
Project manager, Gerry Longanecker (GSFC);  
Project scientist, Anne B. Underhill (GSFC).

Funding: \$5.3 million obligated through June 1974.



Program: Interplanetary Monitoring Platform  
(IMP)

Description: The IMP program is a series of Explorer-class spacecraft designed to extend our knowledge of Sun, Earth, Moon relationships by conducting a continuing study of the radiation environment of the interplanetary medium. They perform detailed and near-continuous studies of the interplanetary environment for orbit periods comparable to several rotations of active regions on the Sun; study particle and field interactions; investigate, during a period of changing solar activity, through several solar rotations, the nature and features of the solar wind, the interplanetary field and cosmic rays. Spacecraft are launched by Delta vehicles from Cape Canaveral or Western Test Range into highly elliptical Earth orbits (except for one lunar-anchored IMP, Explorer 35).

Schedule: Previous IMP launches were Explorer 18, November 1963; Explorer 21, October 1964; Explorer 28, May 1965; Explorer 33, July 1966; Explorer 34, May 1967; Explorer 35 (lunar orbit), July 1967; Explorer 41, June 1969; Explorer 43, March 1971; Explorer 47, September 1972; Explorer 50, October 1973.

Management: Project management, Goddard Space Flight Center, which develops the spacecraft in-house.

Program Officials: Program manager, John R. Holtz;  
Project manager, Paul Butler (GSFC);  
Program scientist, Erwin R. Schmerling;  
Project scientists, Frank B. McDonald  
and Norman F. Ness (GSFC).

Funding: \$69 million obligated through June 1974.

Program: Large Space Telescope (LST)

Description: The concept of the LST calls for a 3-meter (10-foot) class telescope orbiting the Earth and operating at very near the diffraction limit; it would make possible astronomical observations deeper into space and with more detail than has ever been possible. The LST will be designed like ground-based telescopes to use a number of different scientific instruments at its focal plane. This general purpose characteristic will permit the LST to be used effectively as a national facility, capable of supporting worldwide astronomical needs of an international user community. The LST will circle the Earth at an altitude of approximately 611 kilometers (380 miles and at an inclination to the equator of 28.8 degrees. Electrical power for the system will be supplied with the aid of solar panels. The LST will weigh 10 tons.

Schedule: Scheduled to be placed in orbit via the Space Shuttle in 1981/82.

Program Management: Marshall Space Flight Center, with participation by Goddard Space Flight Center and other NASA centers. Industrial contractors. ITEK CORP. and the Perking Elmer Corp.

Program Officials: Program manager, M.J. Aucremanne  
Program scientist, Nancy G. Roman  
Project manager, James A. Downey, III (MSFC)  
Project scientist, C.R. O'Dell (MSFC).

Funding: Current funding limited to study and definition effort. Initial project funding tentatively planned for FY 1977.

Program: Orbiting Astronomical Observatory (OAO)

Description: Complex 2,250-kilogram (5,000-pound) spacecraft launched by Atlas-Centaur from Cape Kennedy into 650-kilometer (400-mile) circular Earth orbit to investigate stellar phenomena, galactic and intergalactic medium. The spacecraft provides power, thermal control and precision pointing for the observatory systems. The spacecraft is capable of providing data storage, handling, transmission and reception and is supported by a ground system. Astronomical instruments are capable of observing the electromagnetic spectrum (ultraviolet and X-ray) from space. They measure the emission of diffuse nebulae, map the form and brightness characteristics of faint nebulae, record the brightness of hot stars, obtain absolute spectrophotometry data, observe the spectra of interstellar gas and dust and observe X-ray emissions and their absorption in interstellar space.

Schedule: OAO-3 was launched on August 21, 1972. This spacecraft was the last in the presently approved program. No additional launches presently foreseen. Previous launches were OAO-1, April 1966 (spacecraft failure); OAO-2, December 1968 (successful); and OAO-B in November 1970 (vehicle failure).

Management: Project management, Goddard Space Flight Center. Industrial contractor, Grumman Aerospace Corporation.

**Program Officials:**

Program manager, Michael E. McDonald;  
Project manager, James E. Kupperian;  
Program scientist, Nancy G. Roman;  
Project scientist, James E. Kupperian  
(GSFC);

**Funding:**

\$359.1 million obligated through June 1974;  
runout costs estimated at \$360-365 million.

**Program:** Orbiting Solar Observatory (OSO)

**Description:** Earth orbiting spacecraft designed to obtain high resolution data from the Sun. OSO-I (eye) will investigate the Sun's lower corona, the chromosphere, and their interface in the X-ray and ultraviolet spectral regions to obtain a better understanding of the transport of energy from the photosphere into the corona. Also to be studied are solar-terrestrial relationships and the background component of cosmic X-rays. First six OSO's were in 270-kilogram (600-pound) range. OSO-7 weighs about 625 kilograms (1,400 pounds), while OSO-I will weigh about 1,050 kilograms (2,300 pounds). A guest investigator program opens up the use of the major experiments on OSO-I to qualified scientists from around the world.

**Schedule:** OSO-I is scheduled for launch in mid-1975 from Cape Canaveral. Delta launch vehicle. Previous spacecraft: OSO-1 launched in March 1962; OSO-2, February 1965; OSO-C, August 1965 (vehicle failure); OSO-3, March 1967; OSO-4, October 1967; OSO-5, January 1969; OSO-6, August 1969; and OSO-7, September 1971.

**Management:** Project management, Goddard Space Flight Center. Industrial contractors, Ball Brothers Research Corporation, A-H, and Hughes Aircraft Company, I.

**Program Officials:** Program manager, Michael E. McDonald;  
Project manager, Robert H. Pickard (GSFC);  
Program scientist, Goetz K. Oertel;  
Project scientist, Stephen P. Maran (GSFC);

**Funding:** \$161.6 million obligated through June 1974.

**Program:** Radio Astronomy Explorer (RAE)

**Description:** RAE is a gravity-gradient stabilized 250-kilogram (550-pound) satellite which was placed into a 1,100-kilometer (684 mile) circular lunar orbit. It has 250-meter (750-foot) extendable antennas, giving an overall satellite length in space of 500 meters (1,500 feet). RAE was designed to make measurements of galactic and solar radio noise, at frequencies below the ionospheric cut-offs and outside terrestrial background interference, by using the Moon for occultation and focusing.

**Schedule:** RAE-B (Explorer 49) was launched June 1973 from Cape Kennedy. Launch vehicle: Delta. Previous launch: Explorer 38, July 1968 (Earth orbit).

**Management:** Goddard Space Flight Center, which develops spacecraft in-house.

**Program Officials:** Program manager, John R. Holtz;  
Project manager, John T. Shea (GSFC);  
Program scientist, Nancy G. Roman;  
Project scientist, Robert G. Stone (GSFC).

**Funding:** \$20.4 million obligated through June 1974.

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Program: Small Astronomy Satellite (SAS)

Description: SAS is an Earth-orbiting 145-190 kilogram (320-425-pound) Explorer-class spacecraft which surveys the celestial sphere and searches for sources radiating in the X-ray, gamma-ray, ultraviolet and other spectral regions both inside and outside our Galaxy. SAS-A and C carry X-ray instruments; SAS-B carried a gamma-ray instrument.

Schedule: SAS-C will be launched in 1975 to investigate X-ray sources. Previous launches were Explorer 42 (SAS-A), December 1970 and Explorer 48 (SAS-B), November 1972.

Management: Project management, Goddard Space Flight Center. Spacecraft control section contractor, Applied Physics Laboratory, Johns Hopkins University.

Program Officials: Program manager, John R. Holtz;  
Project manager, Marjorie Townsend (GSFC);  
Program scientist, Nancy G. Roman;  
Project scientist, Carl E. Fichtel (GSFC).

Funding: \$44 million obligated through June 1974.



**Program:** Small Scientific Satellite (SSS-A)

**Description:** Earth orbiting Explorer-class spacecraft to investigate the Earth's ring current and development of the main phase of magnetic storms, the relation between auroral phenomena, magnetic storms, and the acceleration of charged particles within the inner magnetosphere and time variations of the trapped particle population.

**Schedule:** Explorer 45 was launched in November 1971 from San Marco platform, Kenya. Scout launch vehicle.

**Management:** Goddard Space Flight Center, which developed spacecraft in-house.

**Program Officials:** Program manager, John R. Holtz;  
Project manager, Gerald W. Longanecker (GSFC);  
Program scientist, Erwin R. Schmerling;  
Project scientist, Robert A. Hoffman (GSFC).

**Funding:** \$6.8 million obligated through June 1974.

Program: UK-5 (NASA/United Kingdom Cooperative)

Description: UK-5 is a 140-kilogram (308-pound) spacecraft designed to investigate galactic and extragalactic X-ray sources. UK-5 was launched into a 510-kilometer (316-mile) circular orbit. Spin-stabilized, with gas jets for control.

Schedule: UK-5 was successfully launched from San Marco Oct. 15, 1974. Launch vehicle, Scout.

Management: Project management for the U.K., Science Research Council (SRC). Spacecraft contractor, Marconi Space Systems Division, GEC (U.K.)

Project management for NASA, Goddard Space Flight Center.

Program Officials: Program manager, John R. Holtz;  
Project manager, Herbert L. Eaker (GSFC);  
Program scientist, Nancy G. Roman;  
Project scientist, Stephen S. Holt (GSFC).

Funding: For NASA: \$542,000 obligated through June 1974.

**Program:**

**Sounding Rockets**

**Description:**

Includes all rockets launched for short-term measurements to a distance usually less than one Earth radius (6,400 kilometers: 2,172 miles). Specifically included are studies of the Earth's atmosphere above the limits of balloon flights (about 32 kilometers: 20 miles), up to the lowest satellite investigations (about 160 kilometers: 100 miles). Sounding rockets also measure the pressure, density, and temperature of the ionosphere, aurorae and airglow, solar flares, geomagnetic storms, trapped radiation fluctuation and meteor streams. Biological specimens as well as scientific instruments have been flown on test flights prior to satellite or deep space missions. By adding attitude stabilization systems, some sounding rockets have been used for stellar astronomy experiments in the X-ray, ultraviolet and radio regions of the electromagnetic spectrum.

**Schedule:**

More than 1,700 sounding rockets have been launched under OSS direction. The launch rate will continue at about 80 per year. Rockets include Arcas, Nike-Apache, Nike-Cajun, Nike-Tomahawk, Aerobee 150, 170 and 350, Javelin, Black Brant III, Black Brant VC, and Astrobee D. Launch ranges include Wallops Flight Center; White Sands, N.W.; Fairbanks and Point Barrow, Ala.; Fort Churchill and Resolute Bay, Canada; Thumba, India; Kiruna, Sweden; Kourou, French Guiana.

Management: Goddard Space Flight Center, Wallops Flight Center and Ames Research Center. Rocket stages are built by a variety of companies. Scientific payloads are provided by a number of universities, private industry and government institutions in the U.S. and overseas.

Program Officials: Program manager for scientific sounding rockets, John R. Holtz;  
Program manager for meteorological sounding rockets, William C. Spreen;  
Project manager, Karl R. Medrow (GSFC);  
Project manager, Larry J. Early  
(Wallops Flight Center);  
Center);  
Project manager, Edward A. Gabris  
(ARC)

Funding: Current level of effort is approximately \$20 million.



# Planetary Programs

**Program:**

Mariner Mars 1971

**Description:**

First U.S. mission to orbit another planet. The original plan was to launch two spacecraft. However, a failure of the second stage of the Atlas/Centaur on May 8, 1971 prevented Mariner 8 from achieving trajectory to Mars. Mariner 9 was successfully launched on May 30, 1971, and encountered Mars on November 13, 1971.

Objective of Mariner 9 was to orbit Mars for at least 90 days, mapping about 70 per cent of the planet's surface and viewing selected areas during dynamic changes on Mars. Spacecraft carried two TV cameras and infrared and ultraviolet instruments to measure surface temperatures, temperatures and constituents of the atmosphere and composition of the surface including polar caps.

Mariner 9 is orbiting Mars at an altitude of 17,000 kilometers by 1,650 kilometers (10,540 miles by 1,023 miles) at an inclination of 64.4 degrees and with a 12-hour period. Orbit was designed to accomplish as many of the scientific objectives of both spacecraft as possible.

First planetary mission to use real-time adaptive mode operations in which data from each orbit is analyzed by science teams to direct study of areas of greatest interest on subsequent orbits.

Mariner 9 collected data for 349 days from November 13, 1971 to October 27, 1972. Data returned included 7,329 pictures of the planet and its satellites; hundreds of thousands of infrared and ultraviolet measurements; hundreds of S-band occultation experiment measurements and a wealth of information associated with the celestial mechanics experiment. This data has changed our picture of Mars from that of a dead, moon-like planet to a living, dynamic planet, and provided visual mapping of 100 per cent of the planet's surface. Mariner 9 will continue to orbit Mars for 50 to 100 years, but the transmitter was silenced by command on October 27, 1972 because of depletion of altitude control gas.

Management:

Project management: Jet Propulsion Laboratory, which developed the spacecraft in-house.

Program Officials:

Program manager, Earl W. Glahn;  
Project manager, Dan Schneiderman  
(JPL);  
Program scientist, Harold F. Hipsher;  
Project scientist, Robert H.  
Steinbacher (JPL).

Funding:

\$133.6 million obligated through June 1974.

Program: Mariner Venus/Mercury 1973 (Mariner 10)

Description: A 504-kilogram (1108-pound), modified Mariner type spacecraft, carrying television and six other scientific instruments, flew by Venus to obtain a gravity assist/trajectory deflection in order to fly within close proximity of Mercury, the closest planet to our Sun. The mission was designed to conduct investigation of both planets including measurements of atmosphere, surface and planetary characteristics of Mercury. Due to Mercury's close angular proximity to the Sun, it has received relatively little observational study. However, for the same reason, it is one of the most important planets to study to obtain data bearing on the origin and history of the solar system.

The pictorial data obtained will help define Venus' atmospheric parameters such as structure, circulation, composition and distribution. Photographs of Venus show the planet's dense cloud blanket as well as its ultraviolet "clouds" which appear to rotate around the planet every four days.

Best picture resolution of the surface of Mercury was 100 meters (30.48 feet). Before that, only gross shading characteristics of Mercury could be distinguished with Earth-based telescopes. Mercury photography was used to map and identify major physical landmarks, determine the orientation of the spin axis and establish a cartographic coordination system.

Other experiments detected and measured a small atmosphere; characterized the surface thermal properties; determined plasma and magnetic field environment; obtained measurements directed toward defining the surface composition; and obtained data to improve existing information relative to the gravitational potential, mass, shape and ephemeris of Mercury.



During the interplanetary cruise portion of the mission, continuous data was obtained relating to radial gradients of magnetic fields, charged particle characteristics and plasma waves.

Schedule:

Mariner 10 was launched on November 3, 1973, and flew within 5,800 kilometers (3,600 miles) of Venus in February 1974. It continued on, passing within 704 kilometers (437 miles) of Mercury on March 29, 1974. Because of the helio-centric trajectory of the spacecraft after Mercury encounter, a second encounter occurred on September 21, 1974, and a third encounter occurred in March 1975.

Management:

Project management: Jet Propulsion Laboratory.  
The Boeing Company, Seattle, Wash., selected as the spacecraft systems contractor in April 1971.

Program  
Officials:

Program manager, N.W. Cunningham;  
Project manager, W.E. Giberson (JPL);  
Program scientist, Stephen Dwornik;  
Project scientist, James Dunne (JPL).

Funding:

\$96.1 million obligated through June 1974.

Program: Mariner Jupiter/Saturn 1977

Description: Two 750-kilogram (1,600-pound) spacecraft will be launched during the August-September '77 opportunity to fly by Jupiter and Saturn and conduct exploratory investigations of the Jupiter and Saturn planetary systems and the interplanetary medium out to Saturn. Primary emphasis will be placed on the conduct of comparative studies of the Jupiter and Saturn systems by obtaining measurements of the environment, atmosphere and body characteristics of the planets, and one or more of the satellites of each planet; studies of the nature of the rings of Saturn and exploration of the interplanetary (or interstellar) medium at increasing distances from the Sun.

Major investigations will include imaging, radio science, infrared and ultraviolet spectroscopy, magnetometry, charged particles, cosmic rays, photopolarimetry planetary radio astronomy, plasma and plasma wave.

The spacecraft will be three-axis stabilized with a 3.7 meter (12-foot) diameter antenna pointed toward Earth. A scan platform will be provided for those investigations requiring pointing control. Radioisotope Thermoelectric Generators (RTG) will be used as the primary source of spacecraft electrical power.

Schedule: First spacecraft will be launched in August 1977; second in September 1977 from Cape Kennedy. Titan III/Centaur/Burner II launch vehicle. Flight time to Jupiter - 1.6 to 1.7 years; flight time to Saturn - 3.4 to 3.7 years.

Management: Project management, Jet Propulsion Laboratory, which develops space-craft in-house.

Program Officials: Program manager, J. W. Keller;  
Project manager, H. M. Schurmeier;  
Program scientist, M. A. Mitz;  
Project scientist, E. C. Stone.

Funding: \$41.3 million obligated through June 1974.

Program: Pioneer 10 and Pioneer 11

Description: Two 259-kilogram (570-pound) spacecraft, adapted from preceding Pioneers, launched by Atlas/Centaurs from Cape Kennedy, to make exploratory investigations beyond the orbit of Mars of the interplanetary medium, the nature of the asteroid belt and the environmental and atmospheric characteristics of the planet Jupiter.

Each spacecraft is capable of performing 13 scientific experiments in space, including photographing Jupiter and measuring its radiative energy and field and particle environment.

During the trip to Jupiter, which takes two years and covers more than a billion kilometers (over half a billion miles), the 60 pounds of instruments measure solar plasma; energetic particles, cosmic rays, neutral hydrogen density and the interplanetary magnetic field. They also measure the velocities, mass properties and flux of asteroids and meteoroids to estimate better the characteristics of cosmic debris and to gauge their potential hazard to spaceflight.

Radioisotope Thermoelectric Generators (RTG) are used as the primary source of spacecraft electrical power. The Pioneers are spin-stabilized with a 2.7-m (9-ft.) diameter antenna pointed constantly at Earth.

Pioneer 10 was launched on March 2, 1972, and swept past the planet Jupiter at a distance of 131,400 kilometers (81,000 miles) on Dec. 3, 1973, making measurements and taking photographs. Culminating a two-year, billion-kilometer (600-million-mile) journey, the encounter marked the beginning of man's probe of the outer solar system. Pioneer 10 was the first spacecraft to fly beyond the orbit of Mars, the first to penetrate the Asteroid Belt and may eventually become the first manmade object to escape the solar system.

Pioneer 10 returned more than 300 closeup pictures of Jupiter and its inner moons, and provided new information on its turbulent atmosphere and cloud currents, its bizzare Red Spot, its murky interior and the surrounding magnetic, field and radiation belt environments.

Pioneer 10 is now on its five-year extended mission--to reach the orbit of Saturn in 1976, and the orbit of Uranus, two billion miles away, the limit of spacecraft communications with Earth, in 1979. The spacecraft will then continue its journey out of the solar system.

At year's end, Pioneer scientists were completing their study of radiation belt data obtained by the spacecraft and concluded that a second Jupiter probe could be safely retargeted closer to the giant planet and then on to Saturn.

The second probe, Pioneer 11, launched on April 5, 1973, arrived at Jupiter on Dec. 3, 1974. It flew by the planet at a distance of about 46,400 km (29,000 mi.), three times closer than its predecessor. The spacecraft, renamed Pioneer Saturn, is scheduled to arrive at the ringed planet in September, 1979.

Management:

Project management: Ames Research Center. Industrial contractor, TRW Systems, Inc.

Program  
Officials:

Program manager, Fred Kochendorfer;  
Project manager, C.F. Hall (Ames);  
Program scientist, Albert Opp;  
Project scientist, John H. Wolfe (Ames).

Funding:

\$87.5 million obligated through June 1974.

Program: Viking

Description: Two automated spacecraft will be sent to Mars, each consisting of a 2,320-kilogram (5,320-pound) orbiter and a 1,957-kilogram (2,000-pound) lander. Primary emphasis will be on studying the environment of Mars and the search for signs of extraterrestrial life. After launch by a Titan-Centaur from Cape Canaveral, orbiter and lander remain mated during the 736-million-kilometer (460-million-mile) trip to Mars and initial reconnaissance of the planet. The lander then detaches and lands, using parachute and retrorockets.

Orbiter science includes TV cameras, water vapor and temperature mapping. Lander science includes two color TV cameras; experiments for biological, organic and inorganic analysis of Martian soil; and instruments to determine atmospheric composition and structure; pressure, temperature and wind, and a seismometer.

Lander will be powered by radioisotope thermoelectric generators. Sterilization procedures will assure that chances of contaminating Mars with Earth microorganisms are less than one in a million.

Schedule: Two spacecraft will be launched from ETR in late summer 1975, arriving at the planet in mid-summer 1976. Viking is a follow-on to the 1964-65, 1969 and the 1971 Mariner flights to Mars.

Management: Project management: Langley Research Center. LaRC also manages lander with Martin Marietta Corp. as industrial contractor. Orbiter management, Jet Propulsion Laboratory.



Program Officials:

- Program manager, Walter Jakobowski;
- Project manager, James Martin (LaRC);
- Program scientist, Dr. Richard Young;
- Project scientist, Dr. Gerald Soffen  
(LaRC)

Funding: \$726.1 million obligated through June 1974.

**Program:** Helios (a cooperative project with the Federal Republic of Germany)

**Description:** Under agreement of June 10, 1969, between the West German Ministry of Science and Education and NASA, the two countries are cooperating in developing two probes, Helios A and B, to investigate space close to the Sun within approximately 45 million kilometers (28 million miles).

The 370-kilogram (815-pound) spacecraft are being developed by West Germany. NASA will provide Titan III-D/Centaur launch vehicles, launching services, and support by the Deep Space Network. Seven of the 10 experiments will be provided by German scientists and three by NASA in cooperation with U.S., Australian and Italian scientists.

The scientific objectives are to investigate the properties of and processes in interplanetary space close to the Sun (about 0.3 AU).

**Schedule:** Helios-A was launched from Cape Canaveral on Dec. 10, 1974. Helios-B is scheduled for launch in early 1976.

**Management:** German project management: Gesellschaft fuer Weltraumforschung (Gfw) Contractor, Messerschmitt-Bolkow-Blohm GmbH.  
NASA project management: Goddard Space Flight Center.

Program Officials:

For NASA: Program manager, Fred  
Kochendorfer;  
Project manager, Gilbert W. Ousley  
(GSFC);  
Program scientist, Alois W. Schardt;  
Project scientist, James H. Trainor  
(GSFC).

Funding:

For NASA: \$8.1 million obligated through  
June 1974.

Program: Pioneer Venus 1978

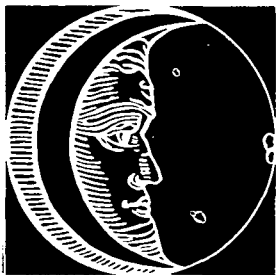
Description: Two spacecraft, an orbiter and a lander, are due to arrive at Venus late in 1978. The orbiter, carrying 38 kilograms (185 pounds) of instruments, is designed to study the atmosphere over one 243-day period, coming as close as 200 kilometers (125 miles) to the planet's surface. The multiprobe bus will drop one large and three small probes toward the surface and will then send back data as it enters the atmosphere. Primary objective of the twin missions is to gather detailed information on Venus' atmosphere and clouds, which could lead to a better understanding of our own atmosphere. Thirty-eight scientists, including one each from France and Germany, have been chosen by NASA to provide the experiments for Pioneer Venus.

Schedule: Two spacecraft will be launched from ETR in May and August, 1978, arriving at Venus in December 1978.

Management: Project management: Ames Research Center

Program Officials: Program manager, Fred Kochendorfer (Hqs.);  
Deputy program manager, Paul Tarver (Hqs.);  
Project manager, C. F. Hall (ARC);  
Program scientist, Dr. Robert F. Fellows (Hqs.);  
Project scientist, Dr. Lawrence Colin (ARC).

Funding: Initial project funding planned for FY 1975.

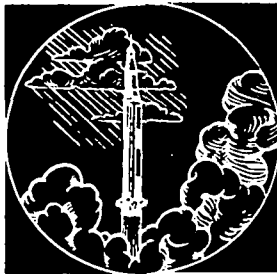


# Lunar Programs

The Lunar Programs Office is responsible for the continuing operation, collection and distribution of data from the Apollo Lunar Surface Experiment Packages (ALSEPs). All five packages placed on the lunar surface by Apollos 12, 14, 15, 16 and 17 are still operating, with the majority of the individual experiments still collecting valid scientific data. This office supports the ALSEP and photoanalysis Principal Investigators and generates the necessary cartographic and photographic support products. The Curatorial Facility at Johnson Space Center, Houston, Tex., safeguards, stores, prepares, analyzes and distributed the lunar rock and soil samples returned by the Apollo flights. Over 170 scientific groups of approved investigators are participating in this sample analysis program.

The Lunar Laser Ranging Experiment is utilizing variations in direction and travel time of laser pulses transmitted from the University of Texas' McDonald Observatory and reflected back by retroreflectors emplaced at three Apollo landing sites, to determine changes in orientation and distances of the Earth-moon systems. A second observatory will soon be operating on Mount Haleakala in Hawaii.

An integral part of the Lunar Program Office is the Lunar Data Analysis and Synthesis Program which seeks to develop, through all available data, a detailed picture of the origin, evolution and present environment of the moon and to extend ultimately these results to a better understanding of our Earth and Solar System.



# Launch Vehicles

## SCOUT

Scout is the smallest and only all-solid-fuel launch vehicle in the national launch vehicle stable. It is used for a large variety of small scientific payloads such as atmospheric and space probes, high speed reentry experiments and small satellites.

From October 1963 to August 1974, 65 Scouts were launched with a 95 per cent success rate. The last 33 launches have all been successful.

Mission Capability: Can put 186 kilograms (410 pounds) in 555-kilometer (300-mile) orbit, due east from Wallops Station, Va.

<u>Stages</u> (Four)	<u>Fuel</u>	<u>Thrust</u>
Algol III-A	Solid	481,704 newtons (108,287 pounds)
Castor II-A	Solid	281,039 newtons (63,178 pounds)
Antares IIB	Solid	126,830 newtons (28,511 pounds)
Altair III	Solid	26,226 newtons (5,896 pounds)

Scout is 23 meters (72 feet) tall with a maximum diameter of 1.12 meters (3.67 feet).

Management: Langley Research Center

Program Officials: Program manager, Paul E. Goozh; NASA Hqs.  
Project manager, Roland D. English (LaRC)

Prime Contractor: Vought Systems Division, LTV Aerospace Corp.

Funding: \$124.7 million obligated through June 1974.

## DELTA

Delta is an economical, reliable launch vehicle used for a wide variety of medium-size satellites and small space probes. It may be used as a two-or three-stage vehicle with a three, six, or nine solid-motor first-stage thrust augmentation.

Through August, 1974, 102 Deltas have been launched with an overall success record of 91 per cent.

Mission Capability: Can put 1,800-kilogram (4,500-pound) payload into 185-kilometer (115-mile) orbit or 386 kilograms (850 pounds) to Mars or Venus (two-stage, nine solids).

<u>Stages (Three)</u>	<u>Fuel</u>	<u>Thrust</u>	<u>Thrust</u>
Thor	Liquid oxygen modified kerosene (LOX/RP-1)		2,298,000 newtons (517,000 pounds) including six of the nine solid strap-ons.
Delta	N <sub>2</sub> O <sub>4</sub> /Aerozene-50		45,800 newtons (10,305 pounds)
TE-364-4	Solid		68,700 newtons (15,500 pounds)

Delta is 35 meters (116.0 feet) tall with a maximum diameter of 2.4 meters (8 feet).

Management: Goddard Space Flight Center

Program Officials: Program manager, Peter Eaton  
Project manager, William Schindler (GSFC).

Prime Contractor: McDonnell Douglas Corporation

Funding: \$415.4 million obligated through June 1974.

## ATLAS/CENTAUR

Atlas/Centaur is a high energy mission, two and one half-stage rocket for launch of medium weight spacecraft into planetary and synchronous orbits. Reliability and flexibility of the Centaur stage is increased to provide additional vehicle performance for support of Viking and subsequent missions with a Titan III booster.

Through August 1974, Atlas/Centaurs have been launched with an overall success record of 88 per cent for operational vehicles.

Mission Capability: Can put 4,700 kilograms (10,300 pounds) into 555-kilometer (345 miles) orbit or 1,810 kilograms (4,000 pounds) into synchronous transfer orbit.

<u>Stages (Two)</u>	<u>Fuel</u>	<u>Thrust</u>
Atlas	Liquid oxygen modified kerosene (LOX-RP-1)	2,236,000 newtons (503,000 pounds)
Centaur	Liquid oxygen and liquid hydrogen (LOX/LH <sub>2</sub> )	130,000 newtons (30,000 pounds)

Atlas/Centaur and shroud are 39.81 meters (131 feet) tall with a maximum diameter of 3.04 meters (10 feet).

Management: Lewis Research Center

Program Officials: Program manager, F. Robert Schmidt  
Project manager, Henry Sloan (LeRC).

Prime Contractor: General Dynamics/Convair

Funding: \$669.2 million obligated through June 1974 for complete Centaur program.



TITAN III C (Air Force)

TITAN III C (Air Force) Launched the Applications Technology Satellite F May 30, 1974.

Mission Capability: Can put 11,820 kilograms (26,000 pounds) into 555-kilometer (345 mile)-orbit, 1,500 kilograms (3,300 pounds) into synchronous orbit.

<u>Stages</u> (Four)	<u>Fuel</u>	<u>Thrust</u>
Stage 0 (two solids)	Solid	10,450,825 newtons (2,350,000 pounds)
Stage I	Nitrogen tetroxide (N <sub>2</sub> O <sub>4</sub> ) and Aerozene-50 (N <sub>2</sub> H <sub>4</sub> /UDMH)	2,320,000 newtons (520,000 pounds)
Stage II	Nitrogen tetroxide (N <sub>2</sub> O <sub>4</sub> ) and Aerozene-50 (N <sub>2</sub> H <sub>4</sub> /UDMH)	456,570 newtons (102,000 pounds)
Stage III	Nitrogen tetroxide (N <sub>2</sub> O <sub>4</sub> ) and Aerozene-50 (N <sub>2</sub> H <sub>4</sub> /UDMH)	70,000 newtons (15,700 pounds)

Titan III C is 40.6 meters (133 feet) tall with a maximum diameter of 3 meters (10 feet).

Management: U.S. Air Force

Program Official: NASA, Roger A. Mattson

Prime Contractor: Martin Marietta (Denver)

Funding: \$23.8 million obligated through June 1974.

TITAN III E/CENTAUR

Mission Capability: Can put 5,136-kilograms (11,300-pounds) into Earth escape orbit, or 3,963 kilograms (8,850-pounds) to Mars or Venus.

<u>Stage (Four)*</u>	<u>Fuel</u>	<u>Thrust</u>
Titan Stage (2 SRM's)	Solid	10,450,825 newtons (2,350,000 pounds)
Titan Stage I	Nitrogen tetroxide ( $N_2O_4$ ) and Aerozine-50 ( $N_2H_4$ /UDMH)	2,320,000 newtons (520,000 pounds)
Titan Stage II	Nitrogen tetroxide and Aerozene. ( $N_2H_4$ /UDMH/ $N_2O_4$ )	456,570 newtons (102,000 pounds)
Centaur (DITR)	LOX/ $LH_2$ )	130,000 newtons (30,000 pounds)

Titan III E/Centaur and shroud are about 53 meters (160 feet) tall with a maximum diameter of 3 meters (10 feet).

Management: Lewis Research Center

Program Official: Program Manager; R. Mattson  
Project Manager; Paul Winslow (LeRC)

Funding: See Atlas/Centaur for total project funding.

\*Fifth stage optional for high velocity missions (Jupiter, etc.)